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Teaching and proficiency assessment for arthroscopy in veterinary surgery: A 2017 survey of diplomates and residents of the American and European College of Veterinary Surgeons

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Abstract: OBJECTIVE: To determine current methods of arthroscopic skills training and proficiency assessment, identify skills considered fundamental to arthroscopy, and evaluate desire for a formal training and assessment program. STUDY DESIGN: Anonymized electronic survey. SAMPLE POPULATION: Diplomates and residents of the American College of Veterinary Surgeons (ACVS) and European College of Veterinary Surgeons (ECVS). METHODS: An electronic survey was distributed in commercial software (Qualtrics, Provo, Utah). Questions were divided into 4 categories: (1) demographics, (2) arthroscopy experience, (3) teaching, and (4) proficiency assessment. Descriptive statistical analysis was performed. Comparisons between groups were performed by using , t tests, and 1-way ANOVA (P .05). RESULTS: In total, 429 diplomates and 149 residents responded (response rate 28%). Overall, 80% of respondents trained using clinical cases. Barriers to simulator training included cadaver/simulator availability and time. Skills deemed most fundamental included anatomic knowledge, precise portal placement, triangulation, and image orientation. Overall, 90% of respondents supported a formal training program with requirement to demonstrate proficiency; 80% believed this should be part of standard ACVS/ECVS residency training. CONCLUSION: Arthroscopic skills are taught by using clinical cases, with subjective proficiency assessment. Fundamental skills are those that may be taught using simulators. There is enthusiasm for formal arthroscopic skills training and assessment. CLINICAL SIGNIFICANCE: Improved acquisition and assessment of fundamental arthroscopic skills is indicated. A validated methodology for formal training using simulators, minimizing morbidity, and facilitating objective evaluation is warranted. This is the first phase of a project to develop and validate a simulator program.

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Teaching and proficiency assessment for arthroscopy in veterinary surgery

Teaching and proficiency assessment for arthroscopy in veterinary surgery: A 2017 survey of Diplomates and residents of the American and European Colleges of Veterinary Surgeons

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Abstract

Objective – To determine current methods of arthroscopic skills training and proficiency assessment, identify skills considered fundamental to arthroscopy, and evaluate desire for a formal training and assessment program.

Study Design – Anonymized electronic survey

Sample Population – Diplomates and residents of the American College of Veterinary Surgeons (ACVS) and European College of Veterinary Surgeons (ECVS)

Methods - An electronic survey was distributed using commercial software (Qualtrics®, Provo, UT). Questions were divided into four categories: 1) demographics, 2) arthroscopy experience, 3) teaching, and 4) proficiency assessment. Descriptive statistical analysis was performed. Comparisons between groups were performed using χ^2, t–tests and one-way ANOVA ($P \leq .05$).

Results - A total of 429 Diplomates and 149 residents responded (response rate 28%). Overall 80% of respondents trained using clinical cases. Barriers to simulator training included cadaver/simulator availability and time. Skills deemed most fundamental included anatomy, precise portal placement, triangulation, image orientation, and use of angled scope. Overall 90% of respondents supported a formal training program with requirement to demonstrate proficiency; 80% believed as part of standard ACVS/ECVS residency training.

Conclusion - Arthroscopic skills are taught using clinical cases, with subjective proficiency assessment. Fundamental skills are those that may be taught using simulators. There is enthusiasm for formal arthroscopic skills training and assessment.

Clinical Significance – Improved acquisition and assessment of fundamental arthroscopic skills is indicated. A validated methodology for formal training using simulators, minimizing morbidity and facilitating objective evaluation, is warranted. This is the first phase of a project to develop and validate a simulator program.

Introduction

Arthroscopy is a commonly performed diagnostic and therapeutic procedure in small and large animal surgery. (Bleedorn) Arthroscopy has been shown to reduce post-operative pain, wound complications and hospitalization time, providing a more rapid return to function when compared with arthrotomy. (Hoelzler, Meyer-Lindenberg, Evans, Bertone, Vatistas) Further advantages such as improved magnification and illumination are likely responsible for the improved rate of detection of meniscal tears in dogs undergoing arthroscopic evaluation. (Pozzi) Residents enrolled in American (ACVS) and European College of Veterinary Surgeons (ECVS) training programs are currently required to complete a minimum total of 23 and 30 arthroscopic procedures respectively in small animal (SA) and 35 and 45 respectively in large animal (LA). (American College of Veterinary Surgeons, Residency Training Standards and Requirements, 2017; European College of Veterinary Surgeons, Training brochure, 2012)

The understanding of how surgical trainees acquire surgical skills is still in its infancy. In both human and veterinary surgery, surgical skills appear to be most commonly taught using the 'apprenticeship-type model'; that is the trainee learns in the operating room on clinical cases under direct supervision. (Bleedorn; Kim) This model is neither cost nor time efficient, and may lead to increased patient morbidity. (Thomas) In a survey of ACVS residents, only 73% of LA and 67% of SA residents documented their arthroscopic training program as adequate. (Kim) Exposure to alternative teaching methods is variable, and there is growing enthusiasm for a more structured overall residency training program. (Kim)

There is mounting pressure within human and veterinary surgery to establish a standardized and validated simulator training program with demonstrated competency to complement the apprenticeship training method, i.e. it is no longer acceptable to practice on patients. (Badash, Zevin) Arthroscopy has a steep learning curve; it has been previously shown that the degree of previous surgical experience in open surgery does not correlate with proficiency in minimally invasive surgical skills. (Figert) Skills required to perform arthroscopic surgery differ in many ways to those of open surgery; specifically in visual-spatial coordination and the requirement for equal dexterity in both hands. Arthroscopy is ideally suited for simulation training, as the required dexterity and basic skills are best acquired through physical instrument handling. (Matsumoto) Fundamental Laparoscopic Surgery (FLS), a web-based education module designed mainly for human surgical residents to learn, practice and objectively document their laparoscopic skills, has been endorsed by the American College of Surgeons (ACS). A Fundamentals of Arthroscopic Surgery Training (FAST) program was developed in 2011 as a collaborative effort between the Arthroscopy Association of North America (AANA), American Academy of Orthopaedic Surgeons (AAOS) and American Board of Orthopaedic Surgery (ABOS). However, this program has yet to be formally adopted by any residency program in human surgery. (Goyal, Tay) Anecdotally, there has been a groundswell of support among veterinary arthroscopists in both the US and Europe for a project to develop, validate and formally adopt a simulator program for training and assessment of arthroscopic skills. However, it remains to be seen if this view is representative of the specialist veterinary surgery training organisations and the community as a whole.

The objectives of this study were: (1) to determine current methods of arthroscopic instruction and proficiency assessment in small and large animal surgery residency programs, (2) to assess the skills Diplomates and residents perceive as fundamental for learning arthroscopy, and (3) to evaluate whether there is the desire amongst Diplomates and residents to implement a formal training and assessment program for arthroscopic skills.

The first hypothesis was that arthroscopic skills are primarily taught using clinical cases in the apprenticeship model, with minimal simulator training. The second hypothesis was that skills considered fundamental for arthroscopic proficiency are those that can largely be taught using simulators. The final hypothesis was that the majority of Diplomates and residents support the development and implementation of a formal training and assessment program for arthroscopic skills.

Materials and Methods

Data collection

The study was exempted from Full Ethical Review and conducted in accordance with the UCD Human Research Ethics Committee (HREC) guidelines. An electronic survey was designed using commercial software (Qualtrics®, Provo, UT). The survey was distributed to all ECVS Diplomates and ECVS residents using the ECVS database. The survey was distributed to ACVS Diplomates and residents for whom email addresses had been collected manually. ACVS program directors were encouraged to forward the email containing an anonymous survey link to ACVS Diplomates and residents. The anonymity of participants was preserved. Responses were included in the analysis if the survey was completed within a pre-defined 4-week period in March-April 2017.

The entire survey comprised 40 questions (Appendix I). Questions were organized into 4 categories: (1) background information and demographics of the study population; (2) arthroscopic experience; (3) teaching techniques; and (4) assessment techniques. Using skip logic, the questions displayed were customized to each individual respondent depending on their previous answers. Therefore, the overall number of questions varied for each participant. Participants could navigate backwards and forwards and alter their answers prior to final submission. Each question contained an option ‘other’ where participants could provide freehand text feedback.

Statistical analysis

Quantitative data were reported using descriptive statistical analysis, percentage (frequency) of response, or mean (±SD). Comparisons were made between Diplomates and residents using a chi-square test; responses were analyzed for differences in species focus (LA, SA), certifying organization (ACVS, ECVS), and practice type (academia, private practice, or combined academia and private practice). Responses of Diplomates were analyzed for difference in experience level (≤ 20 years, > 20 years). Large animal and large animal equine-specific were analyzed together. Comparisons between groups were performed using independent *t*-tests or one-way ANOVA and post-hoc Tukey for pair-wise comparisons. Differences were considered statistically significant at $P < .05$.

Results

Distribution

The survey was known to be distributed to 1143 of 2004 registered ACVS Diplomates and all 618 ECVS Diplomates, 42 ACVS residents and all 275 ECVS residents. The total number of ACVS Diplomates and residents who received the survey is unknown. A total of 223 (11%) of all ACVS Diplomates and 206 (33%) of all ECVS Diplomates responded; 24 Diplomates were concurrent Diplomates of the American College Veterinary Sport Medicine and Rehabilitation. Forty-two ACVS residents and 107 (39%) of all ECVS residents participated. The overall estimated response rate was 28% (578 respondents/2078 known recipients).

Demographics

Forty-four percent of respondents (Diplomates and residents) worked exclusively in academia, 49% in private practice, with 6% working in both academia and private practice. Three hundred and forty nine (64%) denoted SA as their primary species focus; 195 (36%) denoted LA, of which 160 (29%) were equine specific. First year residents constituted 31% of participating residents, second year 22%, third year 29%, fourth year 2%, and individuals who have completed surgery residency training 16%. The experience level of Diplomates was less than 5 years (30%), 5 to 10 years (23%), 11 to 15 years (17%), 16 to 20 years (12%), and more than 20 years (18%). Diplomates with more than 20 years of experience were more likely to be working in academia ($P = 0.003$). The primary clinical focus of Diplomates was general surgery (51%), orthopedics (40%), soft tissue (18%), sports medicine (12%) and oncology (6%). Forty eight percent of

Diplomates did not have a resident at their institution, 40% had one to three residents, and 11% had more than three. Diplomates in academia were more likely to have a resident ($P < .0001$). Sixty percent of all respondents were male and 40% were female; the male:female distribution amongst residents was equal ($P = .238$), however, the majority of Diplomates were male ($P < .0001$). Ninety percent of participants were right hand dominant and 10% were left hand dominant.

Arthroscopy experience

Seventeen percent of residents had had observed or assisted in less than 10 arthroscopy procedures since the beginning of their residency, 45% between 10-30, and 38% more than 30. Private practice residents were more likely to have observed or assisted in more than 100 arthroscopy procedures since the beginning of their residency compared with those in academia ($P = .006$). Forty percent of residents had performed less than 10 arthroscopic procedures as primary surgeon under supervision (Table 1). Sixty-five percent of residents had never performed arthroscopy as primary surgeon without supervision. Overall there was no difference between the number of arthroscopic procedures performed under supervision by residents in academia or private practice ($P = .324$). However, private practice residents were more likely to have performed 50 to 100 procedures as primary surgeon without supervision compared to those in academia ($P = .012$). No differences were found between the number of procedures performed by LA and SA residents ($P = .082$).

Large animal Diplomates performed more arthroscopic procedures per year than SA Diplomates as primary surgeon, whether assisted or not by a resident (P = .019, P = .004, respectively). On average, 20% of SA Diplomates reported performing 10 to 30 arthroscopic procedures per year as primary surgeon with no assistant, 20% assisted by a resident and 22% assisting a resident compared to 27%, 29% and 28% of LA Diplomates, respectively. Large animal Diplomates were also more likely to have performed more than 100 procedures as primary surgeon, with or without resident assistance, than SA Diplomates (P = .016 and P = .003, respectively). Diplomates in private practice were more likely to perform more than 100 procedures per year as primary surgeon with no resident assisting compared with academia (P < .0001).

Based on clinical impression, both SA Diplomates and residents ranked the elbow as the easiest joint to obtain proficiency and the tarsus as the most difficult (Table 2). The mean (±SD) estimated total number of arthroscopic procedures needed for a trainee to reach minimal proficiency (defined as ability to perform the procedure from start to finish under supervision) was lowest for the elbow and highest for the stifle-therapeutic (Table 3). Similar findings were observed regarding the estimated number of arthroscopic procedures required to reach full proficiency (defined as ability to perform the supervision from start to finish without supervision). No difference was found between Diplomates and residents, or between private practice and academia.

Based on clinical impression, both LA Diplomates and residents ranked the fetlock (dorsal) as the easiest joint to obtain proficiency and the medial and lateral femorotibial joints as the most difficult (Table 4). The estimated total number of arthroscopic procedures needed for a trainee to reach minimal and full proficiency was lowest for the fetlock (dorsal) and highest for tenoscopy/bursoscopy and the medial and lateral femorotibial joints (Table 5). No significant difference was found between Diplomates and residents or between private practice and academia.

Teaching techniques

Clinical cases were the most commonly used method of arthroscopic training, with 80% of all respondents having received this type of training more than 10 times (Figures 1 and 2). When ranked from 1 (least useful) to 5 (most useful), clinical cases were the most useful training method (Table 6).

Overall 64% of respondents had participated in an external training course. LA Diplomates and residents were more likely to have participated in an external training course (P = .004). SA residents rated external training courses as more useful than Diplomates did (P = .007). Barriers to external training courses included expense and time.

Formal cadaveric training was more likely to be performed in academic institutions (23%) versus private practices (9%), (P < .0001), and in ACVS (18%) versus ECVS (11%) programs (P = .003). There was no difference between SA and LA or between Diplomates and residents. SA residents rated supervised cadaveric training more useful than Diplomates (P = .027). Thirty-four percent of respondents had performed self-directed cadaver training more than 10 times. LA Diplomates and residents were more likely to have performed self-directed cadaver training than SA Diplomates ($P < .0001$) and SA residents ($P = 0.003$). Lack of time and supervisor motivation were cited as the main barriers to cadaveric arthroscopic training, in addition to cadaver availability for SA Diplomates and residents.

Virtual reality, high fidelity (i.e. synthetic joint) and low-fidelity (i.e. box) simulators were not used as a training method by 91%, 97% and 70% of respondents, respectively, with no difference between Diplomates and residents in either species focus or practice type. Only four percent of respondents working in private practice had access to a simulation box and where available it was solely for self-directed use. In academia, 27% of respondents had access to a simulation box; however, most used it either less than once a year or never. The primary reason cited for not using a simulation box was availability. Other common responses were a preference for cadavers, as well as lack of awareness of the use of simulation boxes.

Respondents were asked to rate 14 different arthroscopic skills on the importance of proficiency in this skill prior to performing on a clinical case under supervision (Table 7). The three most important skills were knowledge of anatomy, precise portal placement and triangulation. There was no difference in rank order between inexperienced (< 20 years of experience) and very experienced arthroscopists (≥ 20 years of experience).

Assessment techniques

By completion of residency training, 60% of residents and 56% of Diplomates believed residents should demonstrate full proficiency (defined as ability to perform a procedure from start to finish without supervision) in basic procedures. LA Diplomates were more likely to expect full proficiency in basic procedures than SA Diplomates (P = .006).

Feedback provided from supervisor to trainee was mostly verbal and informal (92%). Ten percent of residents reported receiving no feedback after performing an arthroscopic procedure, whereas no Diplomate reported not giving any feedback (P < .0001). Verbal, informal feedback was ranked as the most useful type of feedback, followed by verbal and formal. Except for no feedback, written objective feedback was considered least useful. Eighty-one percent of respondents reported they performed subjective proficiency assessment on clinical cases, 45% on cadavers and 10% on simulation box training. Only 9% reported objective proficiency assessment on clinical cases and 4% on cadavers.

In contrast with the above findings, 90% of respondents indicated that there should be a formal training program for arthroscopy with required demonstrated proficiency. Eighty-percent denoted that it should form part of residency training; 48% preferring it be mandatory versus 33% elective. Nine percent specified that formal arthroscopy training with objective assessment could take place in a post-residency fellowship. There was no difference in these results between residents, Diplomates, species focus, certifying organisations and types of practice. Seventy-seven percent advised arthroscopic training should be driven by the certifying organisations (ACVS/ECVS). Of the 10% of respondents that did not believe in formal training with required demonstrated proficiency, 43% reported the current model works well, and 23% reported concerns about additional expense. The main limiting factors for implementation of such a program were simulator availability, supervisor time and supervisor motivation (Table 8). Supervisors were more likely than residents to report resident motivation as a limiting factor; conversely residents were more likely than Diplomates to report supervisor motivation as a limiting factor. Sixty-eight percent of Diplomates and residents stated residents should undergo a practical test for arthroscopy proficiency, with 47% suggesting as continuous assessment and 21% as a single test as a part of or separate to the certifying board examination. The majority of respondents in favor of continuous assessment (70%) preferred it be performed at the training institution by the supervisor. For those that preferred a single test, the majority (84%) suggested it is administered and scored by an independent observer either at the institution (50%) or an independent testing center (35%).

Discussion

This study provides information on current teaching practices and methods of assessment of arthroscopic skills in veterinary surgery residency programs. The apprenticeship model is the most common training method across all surgical residencies. Currently, the completion of the required case log is the only requirement for residency training, with objective grading of proficiency rarely, if ever, performed. Although there is limited appreciation of the value of simulator training, the majority of arthroscopic skills perceived as most important are those that can be taught effectively with simulators. (Goyal, Bouaicha, Coughlin, Braman, Insel, Martin) The majority of respondents support the implementation of a formal training program for arthroscopy, with the requirement for proficiency demonstrated on examination or assessment.

This study could be viewed as a gap analysis; that is an attempt to understand current versus desired training practices. On initial glance, most respondents appear satisfied with current methods of teaching using clinical cases and providing subjective verbal feedback. Similar results have been published in the veterinary literature for general surgical skills, where Diplomates and residents rated the apprenticeship model as the most effective training method. (Kim) In our study, in spite of this reported satisfaction, the majority of respondents declared that they did in fact favor a more formal training program with objective proficiency assessment. The reasons for this disparity between satisfaction with current practices and yet desire for more formal training and assessment are likely multifactorial.

Although convenient, training on clinical patients has several limitations; namely increased patient morbidity, decreased operating room efficiency, and increased cost. (Thomas) In the human field, the value of simulators for the acquisition of basic technical skills outside the operating room has come sharply into focus with concerns for patient safety. When already proficient in basic technical skills, the trainee is free to focus on more complex issues, both technical and non-technical, in the operating room, minimizing patient risk. (Reznick, Karam, Agha, Yule, Arora) A simulation program can complement traditional supervised clinical training by permitting acquisition of technical skills in a low stakes environment, reducing the number of clinical cases required for proficiency. (Arora, Agha, Yule) Although simulators allow for teaching and assessment of technical skills, whether this actually translates to improved proficiency in the operating room (transfer validity), has yet to be determined. (Boutefnouchet, Tay, Hodgins) Investment in simulation programs, however, has been shown to result in cost savings due to shorter operating times and reduced patient morbidity. (Bridges, Seymour, Howells)

The majority of SA and LA Diplomates and residents stated that at the completion of a residency program, full proficiency (defined as ability to perform a procedure from start to finish without supervision) in basic procedures is expected. Proficiency in equine arthroscopic procedures is of specific importance due to the inability to convert many procedures to arthrotomy, in order to reduce anesthetic time and related complications (Wolgien), and to allow rapid and optimal return to function. (Vatistas, Bertone) The minimum number of procedures required to fulfill the ACVS or ECVS residency training requirements (23 or 15 for SA, respectively and 45 or 35 for LA, respectively) (ACVS and ECVS guidelines) is considerably lower than the perceived minimum number of cases required to gain full proficiency in even the easiest joint in dogs (28 cases). For comparison, in humans 170 procedures are required to obtain consultant-level proficiency in diagnostic arthroscopy of the stifle joint. (Price) This suggests that case approximations for full proficiency in even the most difficult procedures (therapeutic stifle arthroscopy in SA at 39 cases and medial and lateral femorotibial joints and tenoscopy/bursoscopy in LA at 30 cases) are vastly underestimated by both Diplomates and residents. To further complicate matters, arthroscopic skills acquired in a specific joint may not be transferable to other joints. (Ferguson) Although further work on the learning curve for common arthroscopic procedures is necessary, these findings support the use of simulator training to supplement traditional apprenticeship-type training and reduce the number of clinical cases required to reach proficiency in each joint.

Although many of our respondents were not explicitly in favor of simulator training, three of the top five skills that they reported as fundamental to arthroscopy (triangulation, correct image orientation and use of an angled scope and light source) have been shown to be easily acquired through training with even the most basic of simulators (Goyal, Bouaicha, Coughlin, Braman, Insel, Martin) and the remaining two (knowledge of normal anatomy and precise portal placement) can be acquired with high fidelity simulators such as cadavers. (Badash, Tuijthof) The overall lack of availability and usage of simulators reported in this study suggests limited appreciation of the types and merits of simulator training, along with concerns regarding financial and time investment. (Karam)

Several arthroscopic skills simulators have been developed in human surgery (Goyal, Bouaicha, Coughlin, Braman, Insel, Martin) but none have yet been officially endorsed by certifying organisations. (Thomas; Nousiainen) In veterinary surgery, a laparoscopic simulator and voluntary laparoscopic training and proficiency program has recently been developed (VALS) and is in the process of validation (Fransson, Tapia-Araya, Fransson, Fransson, Uson-Gargallo, Barry) Simulators vary in fidelity relative to a clinical scenario and can be described as low fidelity (box simulators), up to high fidelity (plastic joints) or virtual reality. Although the difference in cost between low- and high fidelity simulators is vast, no difference has been identified in basic skills acquisition irrespective of the type or expense of simulator employed. (Matsumoto, Middleton, Banaszek, Grober, Sutherland) A cost-effective, portable and readily-available box simulator (for example, Arthro*Box*™, Arthrex, Naples, FL; Sawbones® FAST Arthroscopy Training System, Pacific Research Laboratories Inc., WA) could overcome the financial burden associated with a high-fidelity simulator program. (Goyal, Ahmed)

External training courses, while highly valued by the majority of participants, were not attended due to lack of time and cost. In human surgery, training courses, using mainly simulators, are included in the orthopedic surgeon curriculum. (Nousiainen) A recent study showed that a standardized 4-day arthroscopy-training curriculum could objectively improve basic arthroscopy proficiency. (Martin) Similar intensive training courses at an early stage may be considered as a part of a more structured veterinary surgical training program. This may raise issues in veterinary surgery as residents' working hours become an increasing concern. (Adin)

From the perspective of the certifying organizations, proficiency in arthroscopy is assessed solely on the completion of a minimum number of procedures as part of a case log. Our results demonstrate that proficiency in arthroscopic procedures is most commonly assessed by direct observation in the operating theatre on a live clinical patient with subjective verbal feedback. However, the majority of those surveyed reported that they are in favor of more formal proficiency assessment. Several assessment scales have been developed for proficiency assessment on clinical cases, cadavers and simulators in human surgery; however, none has been proven superior to each other. (Ahmed, Middleton) A validated veterinary surgery assessment scale has not yet been developed for arthroscopic skills assessment. Development and utilization of an adapted assessment scale for simulation training and for clinical cases would permit standardization of program evaluation. Further studies are required in veterinary surgery to describe and validate an assessment scale for arthroscopic skills.

Anecdotally, there has been resistance from supervisors for even the relatively low number of required arthroscopic procedures due to the perceived priority of general surgical skills. This finding was echoed in freehand comments provided by our participants; many respondents commented that a curriculum for training and proficiency in general surgical skills should be prioritized over arthroscopic skills. Conversely, most participants responded that formal training and proficiency testing in arthroscopic skills should be mandatory during residency training, and directed by the certifying organizations.

Limitations

There are several limitations to this study. The responses are subject to recall and largely rely on subjective opinion leading to possible bias. Although all Diplomates and residents of any subspecialty of veterinary surgery were welcome to respond, it is likely that those with a particular interest in veterinary arthroscopy were more likely to participate. All ECVS Diplomates and residents received the electronic survey; however, the contact details of members of the ACVS College had to be collected manually, and are considered incomplete. The overall response rate of 28% could be qualified as low, although this is comparable to most similar electronic surveys. (Safir, Tuijthof)

Conclusion

The results of this survey demonstrate that arthroscopic skills training should form an integral part of resident training. There is interest in the development of a formal training curriculum with required proficiency assessment within the confines of the surgical residency training program. The main barriers include availability of training equipment, time and motivation of the supervisor, and lack of funding; some of which may be overcome with low cost box simulators. The results of this study support a long-term project to develop and validate a simulator-training program and methods for objective proficiency assessment for skills in veterinary arthroscopy.

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Disclosure

The authors declare no conflict of interest related to this report.

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Tables

Table 1: Number of arthroscopies performed as primary surgeon under supervision for each year of residency training (SA and LA); Percentage distribution

	Year 1		Year 2		Year 3	
	SA (n=31)	**LA (n=12)**	**SA (n=25)**	**LA (n=5)**	**SA (n=36)**	**LA (n=5)**
None	68	42	28	20	6	0
< 10	29	58	56	20	39	80
11-30	3	0	16	60	50	20
31-50	0	0	0	0	4	0
51-100	0	0	0	0	0	0
>100	0	0	0	0	0	0

Table 2: Joint rank order based on perceived difficulty in obtaining proficiency (SA)

1 = least difficult, 5 = most difficult; (mean ± SD); * = statistically significant

Location	Diplomates	Residents	P-value
Tarsus	4.25 ± 0.820	4.24 ± 0.819	0.936
Carpus	3.88 ± 1.013	4.21 ± 0.995	0.125
Stifle (therapeutic)	3.86 ± 1.015	3.70 ± 0.886	0.175
Hip	3.62 ± 1.083	3.78 ± 1.128	0.446
Shoulder	3.31 ± 0.958	3.39 ± 0.877	0.505
Stifle (diagnostic)	3.25 ± 0.958	3.08 ± 0.846	0.149
Elbow	2.73 ± 0.943	3.06 ± 0.841	0.003*

Table 3: Estimated number of arthroscopic procedures needed for a trainee to reach minimal and full proficiency (SA)

Location	Proficiency mean (±SD)	
	Minimal	**Full**
Stifle (therapeutic)	28 (±18)	39 (±20)
Tarsus	23 (±15)	32 (±20)
Stifle (diagnostic)	20 (±12)	30 (±16)
Hip	19 (±13)	29 (±20)
Carpus	18 (±13)	29 (±19)
Shoulder	17 (±11)	29 (±17)
Elbow	16 (±10)	28 (±16)

Table 4: Rank order based on perceived difficulty in obtaining proficiency in large animal arthroscopy (LA)

1 = least difficult, 5 = most difficult; (mean ± SD)

Location	Diplomates	Residents	P-Value
Medial/lateral femorotibial joints			
Distal interphalangeal joint			
Tenoscopy/Bursoscopy			
Fetlock (palmar/plantar)			
Femoropatellar joint			
Carpus			
Tarsus			
Fetlock (dorsal)			

Table 5: Estimated number of arthroscopic procedures needed for a trainee to reach minimal and full proficiency (LA)

Techniques	Proficiency	
	Minimal mean (±SD)	**Full** mean (±SD)
Tenoscopy/bursoscopy	21 (±13)	29 (±17)
Medial and lateral femorotibial joints	20 (±12)	30 (±16)
Distal interphalangeal joint	18 (±13)	26 (±16)
Fetlock (palmar/plantar)	17 (±10)	25 (±14)
Carpus	13 (±10)	23 (±14)
Tarsus	13 (±10)	22 (±14)
Fetlock (dorsal)	11 (±10)	19 (±13)

Table 6: Rank order of perceived usefulness of various training methods (SA and LA)

1 = least useful, 5 = most useful; (mean +/- SD); * = statistically significant

Training methods	Diplomates	Residents	P-value
Clinical cases	4.57 ± 0.710	4.64 ± 0.676	0.282
Supervised cadavers	4.22 ± 0.743	4.39 ± 0.787	0.030*
Training courses	4.09 ± 0.800	4.33 ± 0.751	0.004*
Self-directed cadavers	3.83 ± 0.990	3.78 ± 0.950	0.613
High-fidelity simulators	3.40 ± 0.884	3.28 ± 0.908	0.283
Virtual reality simulators	3.07 ± 0.971	2.90 ± 1.057	0.159
Low-fidelity simulators	2.58 ± 0.789	2.58 ± 0.834	0.964

Table 7: Rank order of perceived importance of arthroscopic skills (SA and LA)

1 = least important, 5 = most important; (+/- SD); * = statistically significant

Arthroscopic skills	Diplomates	Residents	P-value
Knowledge of normal anatomy	4.59 ± 0.626	4.53 ± 0.558	0.395
Precise portal placement	4.03 ± 0.891	3.99 ± 0.925	0.655
Triangulation	4.00 ± 0.916	3.92 ± 0.871	0.384
Correct image orientation	3.96 ± 0.887	3.81 ± 0.827	0.085
Use of angled scope and light source	3.75 ± 0.947	3.69 ± 0.931	0.514
Depth control	3.59 ± 0.909	3.54 ± 0.821	0.567
Probing stationary target	3.51 ± 0.949	3.39 ± 0.891	0.212
Curettage	3.40 ± 1.104	3.28 ± 0.963	0.279
Removal of loose bodies	3.37 ± 1.045	3.28 ± 0.960	0.802
Probing moving target	3.20 ± 1.078	3.24 ± 0.935	0.715
Resection of soft tissue	3.11 ± 1.007	3.10 ± 0.940	0.930
Use of arthroscopic blade	3.10 ± 1.140	3.09 ± 1.077	0.926
Use of electrical/radiofrequency energy	2.66 ± 1.247	2.83 ±1.215	0.171
Arthroscopic suturing	2.14 ± 1.224	2.48 ± 1.356	0.012*

Table 8: Rank order of limiting factors for implementation of a formal training program

1 = least limiting, 5 = most limiting; (+/- SD); * = statistically significant

Limiting factors	Diplomates	Residents	P-value
Simulator availability	3.94 ± 1.332	4.08 ± 1.339	0.371
Supervisor time	3.67 ± 1.018	3.85 ± 1.009	0.100
Supervisor motivation	2.85 ± 1.145	3.31 ± 1.206	<0.000*
Resident time	2.89 ± 1.152	3.08 ± 1.274	0.146
Expense	2.92 ± 2.021	3.25 ± 2.062	0.780
Cadaver availability	2.88 ± 1.357	2.56 ± 1.321	0.032
Caseload	2.79 ± 1.253	2.74 ± 1.316	0.730
Facility availability	2.52 ± 1.322	2.42 ± 1.354	0.508
Supervisor expertise	2.38 ± 1.313	2.35 ± 1.237	0.842
Equipment availability	2.43 ± 1.325	2.25 ± 1.388	0.249
Resident motivation	2.23 ± 1.062	1.50 ± 0.774	<0.000*

Figures:

Figure 1: Frequency of training methods in small animal arthroscopy (Diplomates and residents)

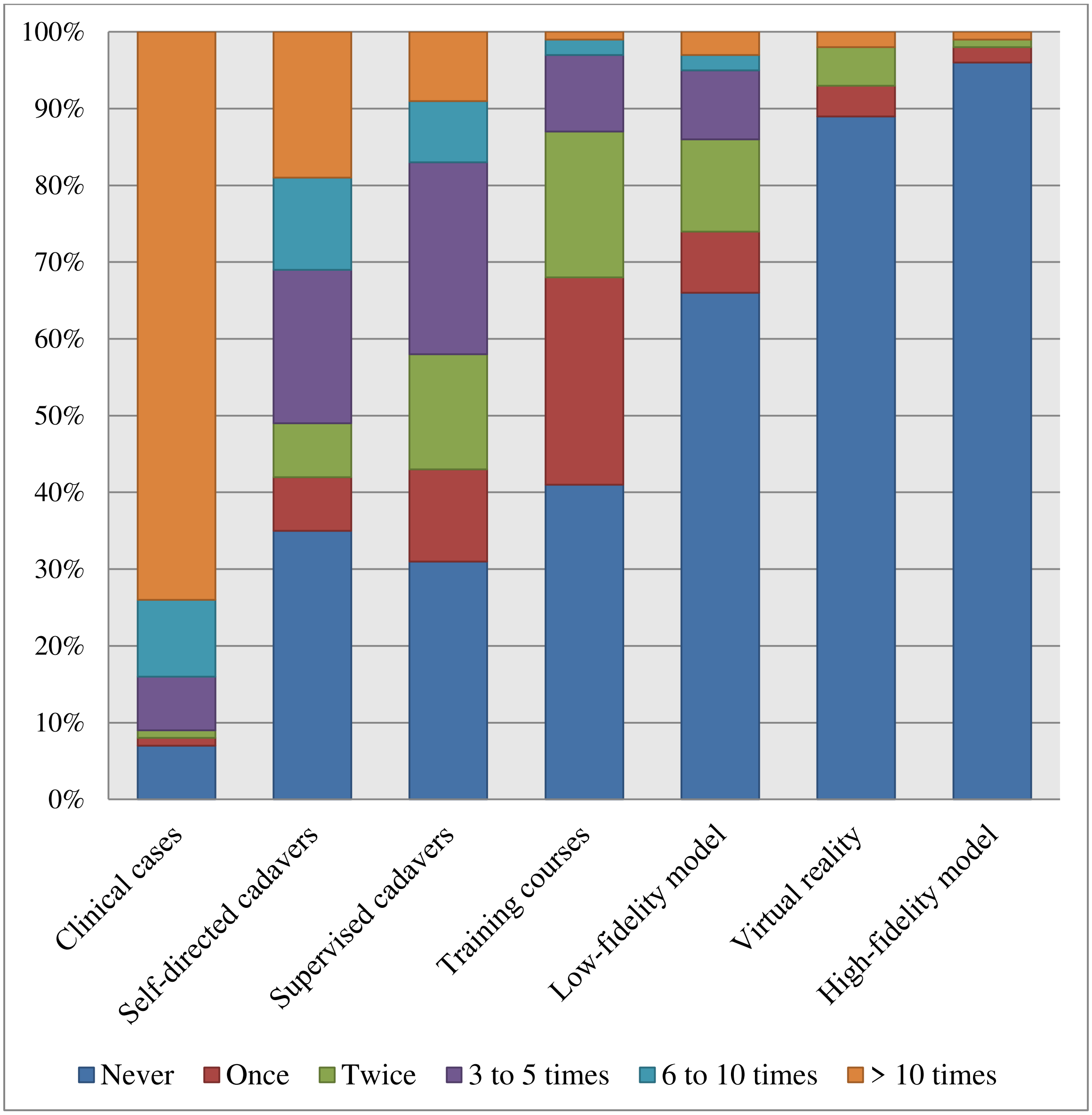

Figure 2: Frequency of training methods in large animal arthroscopy (Diplomates and residents)

* = statistically significant difference between large animal and small animal arthroscopy